CHAPTER 2. AFFECTED FISHES

FISH STOCKS OF KING COUNTY RIVERS

Rivers and streams that fall within the influence of the King County River Management Program support more than 29 individual stocks of salmonid fishes (Wydoski and Whitney 1979; WDFW and WWTIT 1994a, 1994b; Busack and Shaklee 1995; WDFW 1998; Blakley et al. 2000). These include:

- Seven distinct stocks of chinook salmon (*Oncorhyncus tshawytscha*). These stocks are all part of the Puget Sound evolutionarily significant unit (ESU) that is listed as threatened under the Endangered Species Act (ESA) (Myers et al. 1998; Rosenberg 1999).

- Six distinct stocks of coho salmon (*Oncorhyncus kisutch*). These stocks are all part of the Puget Sound/Strait of Georgia ESU that is a candidate for listing under the ESA (Weitkamp et al. 1995; Diaz-Soltero 1999).

- At least three stocks of bull trout (*Salvelinus confluentus*). These stocks are all part of the Puget Sound/coastal distinct population segment (DPS) that is listed as threatened under the ESA (Barry 1999). NOTE: bull trout and a sister species, the Dolly Varden charr (*Salvelinus malma*), are almost identical in appearance and behavior and their ranges may overlap in our area. For this reason, the U. S. Fish and Wildlife Service (USFWS) has declared Dolly Varden protected under the ESA by virtue of similarity of appearance to threatened bull trout.

- Three distinct stocks of chum salmon (*Oncorhyncus keta*).

- One stock of pink salmon (*Oncorhyncus gorbuscha*).

- One stock of sockeye salmon (*Oncorhyncus nerka*).

- Eight distinct stocks of steelhead (*Oncorhyncus mykiss irideus*) along with an unspecified number of resident rainbow trout populations.

- An unspecified number of stocks of sea-run and resident coastal cutthroat trout (*Oncorhyncus clarki clarki*).

- An unspecified number of stocks of mountain whitefish (Prosopium williamsoni), plus one stock of the rare pygmy whitefish (P. coulteri) in Chester Morse Lake in the upper Cedar River watershed.

This report will focus specifically on those indigenous salmonid stocks that are listed or are candidates for listing under the ESA. These include:

- Chinook salmon stocks: (1) Bridal Veil Creek fall chinook; (2) Snohomish fall chinook; (3) Cedar River summer/fall chinook; (4) Duwamish/Green summer/fall chinook; (5) Newaukum Creek summer/fall chinook; (6) White River spring chinook; (7) White River summer/fall chinook.

- Coho salmon stocks: (1) South Fork Skykomish coho; (2) Snoqualmie River coho; (3) Cedar River coho; (4) Green River/Soos Creek coho; (5) Newaukum Creek coho; (6) White River coho.

- Bull trout stocks: (1) Skykomish River bull trout; (2) Chester Morse Lake bull trout; (3) White River bull trout.

Life-history summaries and habitat needs of these stocks are presented below.

KING COUNTY CHINOOK SALMON STOCKS

Chinook salmon are, on average, the largest-bodied of the Pacific salmon. They are anadromous and semelparous, i.e., they die after spawning once.

Beyond that, chinook stocks display an array of life history tactics including variation in:

- Age at seaward migration (juveniles may spend only weeks to a year or more in freshwater depending on the stock);
- Length of estuarine and ocean residence;
- Ocean distribution and migratory patterns; and
- Age and season of spawning migration. (These fish may return from saltwater as 3-, 4- or 5-year olds, with some stocks having high proportions of small but sexually mature 2-year old "jacks." Upstream migration may occur in spring, summer, fall, or winter, although in Puget Sound there is only one remaining spring-run stock and no winter-run stocks. While generally considered to be fall spawners, some chinook stocks spawn as late as January. Thus, adult fish hold in river or stream habitats from the time they enter from salt water until the time they spawn.)

Healey (1991) states that a large part of the variation in chinook life history could be explained by the fact that the species occurs in two behavioral forms or races, designated *Stream type* and *Ocean type*. *Stream-type* chinook adults usually return to streams to spawn in the spring with juveniles rearing in natal streams for at least one year. *Ocean-type* chinook adults usually return to streams in the summer or fall (and therefore referred to as summer/fall or fall chinook depending on the stock's actual run timing) with juveniles remaining in streams for much less than one year (usually migrating to salt water anywhere from a week or two to a month or two after emergence).

In the Skagit River, Hayman et al. (1996) observed four distinct waves of juvenile chinook migration out of the stream to estuarine habitat that they labeled "freshwater rearing trajectories." Even though not exhibited by all stocks, these trajectories are increasingly being used to describe variation in the juvenile life cycle of chinook salmon throughout the Puget Sound region:

- *Emergent fry*. These fish migrate to estuary habitats almost immediately after emergence from the redds at a size of about 40 mm (1.6 in.). This wave of migration typically occurs in February and March.
- *Fry/fingerling*. These fish migrate to estuaries at lengths ranging from 45 to 70 mm (1.8 to 2.8 in.) after a variable number of days or weeks following emergence. This wave of migration usually peaks in April and May.
- *Fingerling*. These fish do not migrate to estuarine habitats until they have attained a size of 70 mm (2.8 in.) or greater. The bulk of this migration occurs from mid May to late June.
- *Yearling*. These fish reside in the stream for a full year at least and migrate to salt water as yearlings at sizes ranging from 80 to 85 mm (3.0 to 3.3 in.) to 160 mm (6.3 in.). This is the rearing trajectory of *stream type* chinook, which, as noted above, is a life-history strategy usually associated with spring chinook salmon stocks.

Possibly because of their large body size, main channel reaches or larger tributaries are generally (but not always) chosen for spawning by adult chinook (Healey 1991). These fish exhibit a distinct preference for sites with high subgravel water flow such as at the heads of riffles just before the crest of the rapid, on the upstream sides of large gravel dunes oriented across the river channel, or along lateral gravel ridges. Provided this condition of good subgravel flow is met, the fish will spawn in water that is shallow or deep, slow or fast, and where the gravel is coarse or fine (Healey 1991). This apparent preference may also explain the tendency of spawning chinook salmon to aggregate in particular locations and ignore other superficially similar areas (Vronskiy 1972; Geist and Dauble 1998). It may, in turn, also mean that suitable chinook spawning habitat is more limited in most rivers (i.e., more of a limiting factor for chinook population abundance) than superficial observation would suggest.

Preferred chinook spawning areas typically form where river channels have a propensity to braid, form split-channels, or anastomose rather than where the channel is straight and simple (Geist and Dauble 1998). These are the same areas where rivers are often constrained to protect encroaching human development from erosion and channel migration hazards. Constraining rivers in these locations, with

levees and revetments for example, may prevent formation of features that chinook salmon require and may, thus, lead to habitat loss and population declines.

Side channels and braided or anastomosed reaches may also provide rearing habitat for juveniles during their tenure in streams. Springbrooks and back channels provide additional habitat for juvenile rearing. Stream margins are the principal habitats of newly emerged salmonids during the first few crucial weeks after emergence. Smolts also make use of stream margins for shelter during their migration to saltwater.

Bridal Veil Creek Fall Chinook. Bridal Veil Creek is a tributary of the South Fork Skykomish River downstream of Sunset Falls in Snohomish County. It has become the generic name for the stock of fall chinook salmon that originally spawned in the North Fork Skykomish and its tributaries, and in the South Fork Skykomish and its tributaries (including Bridal Veil Creek) up to Sunset Falls. Because Sunset Falls formed a complete natural barrier to upstream migration of anadromous fish, no such fish stocks existed in the King County portion of the South Fork Skykomish drainage until a fish ladder and transport system was installed at Sunset Falls and anadromous fish including Bridal Veil fall chinook were introduced into upstream reaches. Adult chinook salmon have been transported above Sunset Falls annually since 1958 (Seiler et al. 1981; SBSRTC 1999). In recent years, approximately 500 adult chinook per year have been transported above Sunset Falls (SBSRTC 1999).

The spawning period for this stock extends through the month of October with peak activity usually taking place in the second week. While the overall distribution of spawners is shown in Figure 2-1 (WDFW and WWTIT 1994a), major spawning clusters concentrate in two areas: (1) the King County portion of Beckler River from about river mile (RM) 3 to RM 5 downstream of the mouth of Harlan Creek, and (2) the Tye River from about RM 71 to RM 73 (SBSRTC 1999). Alpine Falls at RM 73.5 on Tye River is an impassible barrier and forms the upstream limit of anadromous distribution.

The only information available regarding the duration of stream residence of juveniles of this stock is incidental data from coho smolt trap studies carried out from 1978 to 1982 (Seiler et al. 1981, 1984). These data suggest a higher proportion of *stream-type* smolts, i.e., more age-1 migrants, than one would expect for fall chinook stocks, which are typically *ocean-type* fish that migrate to sea as subyearlings (Healey 1991). Subyearling migration is the norm in other Puget Sound chinook stocks (WDFW and WWTIT 1994a, 1994b). The implication of this is that stream habitat features suitable for both summer and overwinter rearing of juvenile chinook may be of greater importance for the Bridal Veil Creek stock than for most other Puget Sound chinook stocks.

Snohomish Fall Chinook. Although fish of this stock utilize other portions of the Snohomish basin in Snohomish County, including the Skykomish River, Sultan River, Woods Creek, Elwell Creek, and the Pilchuck River, the majority of the stock returns to the Snoqualmie River portion of the basin in King County (WDFW and WWTIT 1994a). Adults return to the system from August through September, with spawning commencing in late September and continuing through mid to late November in the King County streams.

The overall spawner distribution for this stock is shown in Figure 2-2 (WDFW and WWTIT 1994a). Areas of concentrated spawning in King County include (1) the Tolt River the from mouth upstream to about RM 6, (2) the Raging River from the mouth upstream to about RM 5, (3) Tokul Creek from the mouth to the barrier dam at RM 0.5, and (4) the mainstem Snoqualmie River, especially in gravel riffle and channel-split areas downstream of the mouths of the Tolt River, RM 22 to RM 25, and the Raging River, RM 34 to RM 35 (Williams et al. 1975; SBSRTC 1999).

Similar to the Bridal Veil Creek fall chinook stock, a larger percentage of juveniles than is normally found in Puget Sound fall or summer/fall chinook migrate to sea as age-1 smolts (SBSRTC 1999). The implication of this is the same as for the Bridal Veil Creek stock, i.e., that stream habitat features suitable for both summer and overwinter rearing of juvenile chinook may be of greater importance for this stock than for most other Puget Sound chinook stocks.

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Cedar River Summer/Fall Chinook. The Cedar River is now part of the greater Lake Washington drainage basin. At the turn of the century, the Cedar was a tributary of the Black River that was then the outlet of Lake Washington. The Black River, in turn, joined with the White River near Renton to form the Duwamish River. In 1906, the White River was diverted south into the Stuck River, to flow on to the Puyallup River, and the Black then joined the Green River. In 1916, when the Lake Union ship canal was constructed and the Montlake Cut was made, the Black River outlet ceased to flow and the Cedar River was diverted into Lake Washington.

Chinook salmon in the Lake Washington system are classified as summer/fall chinook because of the return timing to fresh water by adult fish. Adults begin to enter the system in early July and continue until late October or early November. Spawning begins in early to mid September and is usually complete by late November.

Adult chinook spawn in the Cedar River from RM 2 near Renton to the Landsburg Diversion Dam at RM 21, (Figure 2-3) (WDFW and WWTIT 1994b; Mavros et al. 2000). Areas of concentrated spawning are located at RM 6 through 7, RM 10 through 11, and RM 13 through 19 (Mavros et al. 2000).

Chinook salmon of this stock are typical *ocean-type* in that juveniles leave the stream as subyearlings. Two waves of juvenile emigration from the stream are observed. The first and often largest wave exits the stream before mid-April, usually almost immediately after the fry emerge from their redds. These fry, which average about 40 mm (1.6 inches) in length, complete their freshwater rearing in Lake Washington. The second wave exits the stream in late May to early June at an average length of 100 mm (4 inches). These fish spend less time in Lake Washington, and leave the lake for saltwater from late June through September of the same year together with surviving first-wave fish. It is interesting to note that these juvenile fish leave the Lake Washington system even as adult fish are returning to spawn the next year class.

Duwamish/Green Summer/Fall Chinook. This stock is also classified as a summer/fall stock, with adults returning to the system from about the first of July through early November. Spawning begins about mid September and extends to late November (Williams et al. 1975; WDFW and WWTIT 1994b).

As shown in Figure 2-4, adult spawning for this stock extends 37 miles of river from approximately RM 24 near Kent to the City of Tacoma water diversion at RM 61 (WDFW and WWTIT 1994b). However, the most intensive chinook spawning occurs from about RM 29.6 near Auburn to about RM 47 upstream of Flaming Geyser Park (Williams et al. 1975; Grette and Salo 1986), and between RM 56 downstream of Kanaskat to RM 61 at the Tacoma diversion dam (Grette and Salo 1986). Some spawning also occurs in lower Soos Creek.

Chinook salmon of this stock are typical *ocean-type* with juveniles leaving the stream as subyearlings (Williams et al. 1975; WDFW and WWTIT 1994b). Juvenile outmigration extends over a period of about three months, beginning in early April and extending to mid July (Williams et al. 1975).

Newaukum Creek Summer/Fall Chinook. This stock, also classified as a summer/fall stock, spawn exclusively in Newaukum Creek, a tributary of the Green River with its confluence at Green River RM 40.7. Adults return from early July through early November. Spawning begins mid September and extends to late November (Williams et al. 1975; WDFW and WWTIT 1994b).

The overall distribution of chinook spawning in Newaukum Creek extends from the mouth to near RM 10 (Figure 2-5) (Williams et al. 1975; WDFW and WWTIT 1994b). No information is available on locations of concentrated spawning within this distribution area.

Chinook salmon of this stock are typical *ocean-type* and juveniles leave the stream as subyearlings. Juvenile outmigration extends over a period of about three months, beginning in early April and extending to mid July (Williams et al. 1975).

White River Spring Chinook. While historically there were other spring-run chinook stocks in south Puget Sound including a stock in the Green River (Williams et al. 1975), the White River spring chinook is the sole remaining stock with this adult run timing. Because this stock was considered critically depressed long before the ESA listing of Puget Sound

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chinook occurred, management agencies have been collaborating in recovery activities for some time (WDFW and WWTIT 1994b; WDFW et al. 1996; Meyers et al. 1998).

Adults of this stock return to the White River from May through mid-September. Age-3 and age-4 adults comprise the bulk of the spawning population. Prior to construction of Mud Mountain Dam at RM 29.6, which blocks upstream migration of anadromous fish, the returning adults traveled to upriver holding and spawning locations in the upper White and Greenwater Rivers in King County and to the Clearwater River and Huckleberry Creek in Pierce County. While spawning still occurs in these locations, the fish that spawn there now are first trapped near Buckley at the Puget Sound Energy diversion. Those fish not bearing a hatchery mark are trucked to release sites above Mud Mountain Dam, from which they swim to their holding and spawning locations. All chinook adults arriving at the PSE diversion prior to August 15 are counted as White River spring chinook. Although a map published by WDFW and WWTIT (1994b) shows the entire length of the bypass reach as a spawning area, actual spawning there has only recently been confirmed in the upper part of the reach between RM 21 and the Buckley diversion (Ladley et al. 1996).

All known and suspected holding and spawning areas for White River spring chinook are shown in Figure 2-6. While most of the fish spawn in September, some spawning activity extends through the middle of October. Juveniles emerge from the gravels from late February through March.

Most spring chinook juveniles are generally regarded as *stream-type*, often remaining in fresh water for a year after emergence (Healey 1991). Studies by Dunston (1955), however, showed that 80 percent of White River spring chinook juveniles actually exhibit *ocean-type* behavior and migrate to marine waters as subyearlings. Migration from the system is extended, spanning from mid-February to the end of October.

Annual returns of White River spring chinook adults for the 10-year period from 1941 through 1950 averaged 2,768 fish, which is taken as the historic level. Returns have declined in the years since then; the 15-year annual average from 1951 through 1975 was 586 fish. Yearly returns dropped to fewer than 100 fish after 1975; just six fish returned to the Buckley trap in 1982.

While hatchery management of White River spring chinook has been ongoing since 1971, the effort was intensified in 1977 with a program of deliberate interdiction to preserve the stock and eventually restore the wild run. Details of this recovery effort can be found in WDFW et al. (1996). Adults were captured at Buckley and then transported to Hupp Springs Hatchery near Purdy, Washington. Juveniles from the Hupp Springs Hatchery were released into Minter Creek, with the hope that adult fish returning to the hatchery would maintain the program. A saltwater captive brood program was also begun to produce greater numbers of adult spawners for the Hupp Springs operation, and later, in 1989, the White River Hatchery was opened near Buckley. Spring chinook juveniles from the White River Hatchery and excess juveniles from the Hupp Springs operation are now transferred to rearing ponds in the middle and upper White River drainage to reseed the natural environment.This recovery program appears to have some success, as numbers of returning wild fish have increased to 550 fish annually. This is approximately 20 percent of historic levels.

White River Summer/Fall Chinook. Adults of this stock return to this system from mid-July through early November. Spawning begins in mid September and extends through late November (Williams et al. 1975; WDFW and WWTIT 1994b). Spawning occurs mainly in the lower White River from the Dieringer Powerhouse at RM 4.5 in Pierce County to the PSE diversion at RM 24.3 (Williams et al. 1975). Some fish of this stock also spawn in the lower Clearwater River in Pierce County, and in the lower Greenwater River in King County from the mouth to about RM 5 (WDFW and WWTIT 1994b). As mentioned above, these fish are transported upstream of Mud Mountain Dam after August 15. Those transported prior to this date are considered to be White River spring chinook (WDFW and WWTIT 1994b).

The distribution of adult spawners of this stock is shown in Figure 2-7 (WDFW and WWTIT 1994b).

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Chinook salmon of this stock are typical *ocean-type* with juveniles leaving the stream as subyearlings. Juvenile outmigration extends for several months, beginning in late February shortly after the fry emerge from their redds and extends into early August (Williams et al. 1975).

KING COUNTY COHO SALMON STOCKS

Like chinook, coho salmon are anadromous and semelparous, i.e., they die after spawning once. Puget Sound stocks predominately exhibit a three-year life cycle, although some adults in some stocks may be four or even five years of age when they return to spawn. Similar to chinook, some coho stocks have a returning component of two year old sexually mature male fish referred to as "jacks." While adults typically return to spawn in the fall or early winter, spawning can occur as late as February or even March in some localities (Sandercock 1991). Coho salmon are not usually limited by the availability of spawning habitat. Although coho salmon do spawn in mainstem reaches, especially where the channel divides, braids, or anastomoses, creating smaller water courses more suitable for this species. Adults also commonly travel upstream to spawn in a variety of habitats including small tributaries. For spawning, coho adults favor small to medium-size gravel substrate (one to five inches), water depths of four to 24 inches, and water velocities of one to three feet per second (Sandercock 1991). Fry emerge from redds in the spring, and juveniles rear in streams for one year (two years for some stocks elsewhere in the coho salmon range) before migrating to salt water.

Because juvenile coho rear in streams, the availability of suitable rearing habitat—both for summer rearing and for the overwintering period—is usually the limiting factor for coho population abundance. Juvenile coho live in slow-moving pools and actively defend territories in pools during summer rearing. They overwinter in deep pools with gravel or cobble that they use for cover. More so than any other salmonid species except perhaps coastal cutthroat trout, coho utilize off-channel ponds and wetlands, side channels, backwaters, back channels, and springbrooks for overwintering (Sandercock 1991). While subyearling juveniles may migrate downstream from natal tributaries in search of suitable rearing habitat, smolt migration to saltwater typically does not occur until the spring of the year following emergence (Sandercock 1991).

South Fork Skykomish Coho. There were no naturally spawning coho in this area prior to hatchery stock introductions in 1952, and 1956 through 1958; many of introduction were out-of-basin transfers from the Green River Hatchery at Soos Creek (WDFW and WWTIT 1994a). As noted above, because Sunset Falls is a complete block to upstream migration of adults, seeding of the system depends on transport of adults upstream of the falls. Adults return to the system throughout September and October; spawning is presumed to take place soon after the fish are transported upstream of the falls (WDFW and WWTIT 1994a).

The distribution of spawning adults for this stock is shown in Figure 2-8 (WDFW and WWTIT 1994a). This encompasses the entire King County portion of the South Fork Skykomish River and its accessible tributaries, the entire King County portion of the Beckler River and its accessible tributaries, the Miller River and its accessible tributaries up to about RM 4, the Foss River and its accessible tributaries to about RM 5, and the Tye River and its accessible tributaries to Alpine Falls at RM 73.5.

Stream rearing juveniles of this stock are presumed to be present throughout the year in the area shown in Figure 2-8. These fish use slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

Snoqualmie Coho. The area occupied by this stock includes the Snoqualmie River from its junction with the Skykomish River to Snoqualmie Falls at RM 40.2, and all of the major and minor tributaries of the system in between. Adults return to this system from early September through December, and spawn from late October through early January (WDFW and WWTIT 1994a).

The overall distribution of this stock is shown in Figure 2-9 (WDFW and WWTIT 1994a). While the mainstem Snoqualmie River up to RM 21 is primarily a migration corridor for the fish, spawning habitat does occur and is utilized upstream of that point (Williams et al. 1975). Tributaries such as Cherry,

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Peoples, Tuck, Harris, Ames, and Griffin Creeks provide good to excellent spawning habitat. Coho also utilize the entire mainstem Tolt River, the lower mile of the North Fork Tolt, and the South Fork Tolt to about RM 8. The Raging River to RM 12 and Tokul Creek to RM 0.5 are also utilized by spawning coho.

As mentioned above, stream rearing juveniles of this stock may be present throughout the year in the area shown in Figure 2-9, utilizing slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

Cedar River Coho. The area occupied by this stock includes the Cedar River from Renton to the Landsburg Diversion at RM 21 (WDFW and WWTIT 1994b). Cedar River coho have a rather prolonged period of return to the river, and spawn later into the spring than other coho stocks. Adult returns to the river from August until early February; spawning occur from mid October until early March (Williams et al. 1975; WDFW and WWTIT 1994b).

The extent of coho utilization of the Cedar River is shown in Figure 2-10. As this stock has not been studied as closely as Cedar River summer/fall chinook, areas of concentrated coho spawning in the mainstem are not known. However, Rock Creek, Downs Creek, and several of the other Cedar River tributaries are known coho spawning tributaries (Williams et al. 1975).

Like the other King County coho stocks discussed above, stream rearing juveniles may be present throughout the year in the area shown in Figure 2-10, utilizing slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

Green River/Soos Creek Coho. The mainstem river and virtually all accessible tributaries of the Green/Duwamish drainage basin are used by coho salmon as far upstream as the City of Tacoma diversion dam at RM 61 (Williams et al. 1975). Adults enter the system in early August, and the run typically continues through January. Spawning commences in mid October and continues through February.

The overall distribution of coho in the Green River and Soos Creek systems is shown in Figure 2-11 (WDFW and WWTIT 1994b). Some coho spawning occurs in the Green River mainstem, particularly in the Green River Gorge area (roughly RM 46.5 to RM 57.5) and near Burns Creek, RM 38, where divided channel areas provide suitable coho spawning habitat (Williams et al. 1975). In the Soos Creek drainage, coho utilization extends upstream as far as Lake Youngs, approximately RM 5. In Covington Creek, a Soos Creek tributary, coho use extends upstream past Lake Sawyer at RM 6.4 to Ravensdale Creek and Ravensdale Lake at approximately RM 10 (Trotter et al. 1996). Other important coho spawning tributaries include Burns, Crisp, Spring Brook, and Hills Creeks (Williams et al. 1975).

Juvenile coho rear throughout the accessible length of the Green/Duwamish mainstem and in each of the tributaries used by spawning adults. Juvenile coho may be present throughout the year in the area shown in Figure 2-11, utilizing slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

Newaukum Creek Coho. Newaukum Creek coho are considered a separate stock by the management agencies (WDFW and WWTIT 1994b), even though their run timing, spawning timing, and juvenile behavior resemble those of the Green River/Soos Creek coho. Adults return to the system from mid to late September to the middle of November; spawning occurs from mid October to the first week of January (WDFW and WWTIT 1994b),

Coho spawn in all accessible reaches of Newaukum Creek and its tributaries up to about RM 11.5, where cascades at the base of the Cascade Mountains block access (Williams et al. 1975). This area is shown in Figure 2-12 (WDFW and WWTIT 1994b),

Like other King County coho stocks discussed above, stream rearing juveniles may be present throughout the year in the area shown in Figure 2-12, utilizing slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

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White River Coho. Although adults of this stock enter the system in mid to late August and continue into early November, counts at the Buckley trap indicate that the run peaks in September and tails off thereafter (WDFW and WWTIT 1994b). Spawning begins in mid October and continues until mid January (Williams et al. 1975).

The overall distribution of this stock is shown in Figure 2-13 (WDFW and WWTIT 1994b). The White River mainstem downstream of RM 20 is primarily a migration corridor. However, coho use all accessible reaches of Boise Creek (confluence with the White River at RM 23.5) up to RM 4.5 where a waterfall blocks further access. Coho are trapped at the Buckley diversion and hauled 10 miles upstream of Mud Mountain Dam for release. These fish spawn in the mainstem White River, especially where the channel is divided and braided, and water courses more suitable for this species are formed. They also spawn in the lower 0.7 mile of Slippery Creek near Greenwater, and in the Greenwater River itself and all of its accessible tributaries up to RM 8.2 (Williams et al. 1975). The remainder of the spawning areas shown in Figure 2-13 are in Pierce County.

Juvenile coho rear in all streams used by adult coho for spawning, and throughout the mainstem White River (Williams et al. 1975). Like all of the stocks discussed above, stream rearing juveniles may be present throughout the year in the area shown in Figure 2-13, using slow pools for summer rearing and deep pools with cover, off-channel ponds, associated wetlands, side channels, back channels, and springbrooks for overwintering.

KING COUNTY BULL TROUT STOCKS

Bull trout exhibit several life history strategies. Fish with the *resident* life history strategy spend their entire lives in their home streams. Generally, these fish do not attain a large size, with 300 mm (12 inches) being about the largest. *Migratory* bull trout may reside in rivers (*fluvial*), lakes (*lacustrine*, also called *adfluvial*), or salt water (*anadromous*) and may attain sizes exceeding 900 mm (35 inches).

Migratory individuals spawn and rear in streams, often in the uppermost accessible reaches. Spawning occurs typically from late August through early November. Adults choose spawning sites in water depths of five to 19 inches and water velocities of 0.4 to two feet per second (Reiser et al. 1997). Juveniles of migratory populations may rear in streams for two to three years or more before migrating to their primary foraging areas. Anadromous fish return to freshwater the same year they go to sea. They typically do not overwinter in saltwater. They seem to prefer larger watersheds, or stream systems with a lake for overwintering. They attain sexual maturity at five or six year of age; unlike the Pacific salmon, they are iteroparous, meaning they may spawn again every year or every other year thereafter. Adults survive spawning very well; their maximum life span may extend to 12 or more years.

Bull trout require colder water temperatures for spawning, incubation, and rearing than other local salmonids. They seldom spawn before the water temperature drops below 8^{O} C (46^{O} F), and successful egg incubation requires temperatures less than 5^{O} C (41^{O} F). In the northern Puget Sound drainages, the downstream limit of successful spawning is observed to be upstream of the winter snow line, i.e., that elevation at which snow remains on the ground throughout the winter (WDFW 1999). Juveniles, subadults, and adult bull trout are seldom found in streams with summer water temperatures that exceed 15^{O} C (59^{O} F), unless the stream has pools with cold groundwater seeps that can provide thermal refuges (Meehan and Bjornn 1991).

The following are the officially recognized bull trout stocks in King County (WDFW 1998; Barry 1999):

Skykomish River Bull Trout. Most of the area occupied by this stock is outside King County in the North Fork Skykomish River (Figure 2-14) (WDSFW 1998). Prior to construction of the Sunset Falls trap and haul fish way in the mid 1950s, bull trout were not known to be present in the King County portion of the system (Kraemer 2001). Following construction of that facility, a few bull trout were transported above the falls and released into the upper South Fork. This established a modest spawning population of about 50 returning adults per year. Fish begin arriving at Sunset Falls as early as late May, and continue into August. Spawning occurs from late August to mid November, with peak activity usually between the first week of October and the first week of November (WDFW 1998)

FIGURE 2-13
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FIGURE 2-14
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A 1993 radio tagging study of bull trout collected at the Sunset Falls facility revealed that almost all of these fish spawn in the East Fork Foss River from RM 4.3 to RM 7 or 8. To access this reach, the fish must ascend a falls and at least two steep cascades that Williams et al. (1975) mapped as impassable by salmon. Bull trout, more so than other salmonids, are capable of ascending such barriers to reach suitable spawning areas (C. Kraemer, WDFW, personal communication 2001).

Chester Morse Lake Bull Trout. A reproducing population of bull trout occurs in the upper Cedar River basin in Chester Morse Lake, the City of Seattle water reservoir (Connor et al. 1997; Reiser et al. 1997; WDFW 1998). This population exhibits the lacustrine or adfluvial life history strategy, with adults migrating into tributaries of the reservoir or to the first five to six miles of the Cedar River upstream of the reservoir for spawning, and the juveniles migrating back to the reservoir to feed and grow. The area used by this stock is shown in Figure 2-15 (WDFW 1998).

Whether anadromous or fluvial bull trout persist in the Cedar River below the City of Seattle water works is a matter of conjecture. Miller and Borton (1980) documented many captures of anadromous native charr in the Shilshole Bay area just off the Lake Washington Ship Canal outlet. More recently, workers studying juvenile chinook predation in that area also captured small numbers of juvenile bull trout (Footen 2000). In addition to these records, a single bull trout (length 370 mm [14.5 in.]) was reported taken by a shore angler fishing in Lake Washington near Kirkland in April 1981 (Pfeifer and Bradbury 1992, cited in WDFW 1998). While these fish are presumed to have originated from somewhere in the Lake Washington drainage, most likely the Cedar River, there is no documentation. There is also oral history of bull trout utilization of Rock Creek, a Cedar River tributary downstream of the Landsburg Diversion Dam (Burlingame 2000); again, there have been no confirmed sightings there. Neither Rock Creek nor any of the other Cedar River tributaries downstream of Landsburg appears to have the full range of conditions necessary to support viable bull trout populations.

White River Bull Trout. Records from the Buckley adult fish trap from 1987 to date show that a small number of migratory bull trout return to the trap each year and are transported upstream of Mud Mountain Dam for release. It is not known whether these fish are anadromous or fluvial. The number has ranged from a low of eight fish in 1988 to 48 fish in 2000 (Crane 2001). The first adult trout arrive at the Buckley trap in May with returns peaking in July before tailing off through August and September. When and where these fish spawn is not known. The only other information available for this stock comes from incidental captures of bull trout during surveys for other species. For example, nine native charr ranging in size from 99 mm (4 in.) to 300 mm (12 in.) were captured by electroshocking in late summer 1993 between RM 43 and RM 53.3 on the White River during a survey for juvenile steelhead (only the lower three miles of this survey, below the mouth of Greenwater River, lie in King County). Four native charr ranging from 127 mm (5 in.) to 203 mm (8 in.) were captured in the West Fork White River in Pierce County during that same survey (WDFW 1998). There are also anecdotal reports of angler-caught bull trout from scattered locations along the upper White River (WDFW 1998).

According to the historical record (Suckley 1859), anadromous native charr (either bull trout or Dolly Varden charr) also returned in great numbers to the Duwamish and Green rivers around the time of first European settlement. Because the Duwamish and Green Rivers were part of the White River system at this time, these fish may have belonged to the White River bull trout stock, a remnant of which is still present. Although a possible bull trout specimen was captured by a member of the Muckleshoot Indian Tribe near the mouth of Newaukum Creek in February 2000, and other captures suggest that anadromous bull trout regularly visit the lower Duwamish River downstream of RM 5.8, especially in the spring. These fish are believed to be migratory visitors from other watersheds that enter the Duwamish perhaps to forage on out migrating smolts (King County 2001). No bull trout have been found in several recent surveys of the upper basin upstream of Howard Hanson Dam; no bull trout stock is presently recognized as existing in the Green River by WDFW (1998).

FIGURE 2-15
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